D448 PCM TRUNK CARRIER SYSTEM

DATAPORT APPLICATION AND DESIGN CONSIDERATIONS

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1. GENERAL

1.01 This Section provides application and design considerations information on the use of ITT dataport channel units. The information in this Section is provided to allow plant and engineering personnel to make decisions regarding what equipment is needed and how it should be configured for specific private line data service applications.

1.02 Whenever this Section is reissued, the reasons for reissue will be listed in this paragraph.

1.03 ITT dataport channel units are plug-in cards for use with ITT D448 PCM trunk carrier systems. They provide access to the AT&T Digital Data System (DDS®) network, or may be used to provide stand-alone private line data service via the D448. The dataport units plug into channel and common unit positions in the D448 multiplex terminal. The units, their descriptions, and mounting locations are listed in Table A.

2. DATAPORT PRIVATE LINE DATA SERVICE-OVERVIEW

GENERAL

2.01 The following paragraphs describe the operation of dataport channel units within D448, the various dataport configurations, and some typical examples of D448 dataport applications.

D448 DATAPORT SUBSYSTEM DESCRIPTION (FIG. 1)

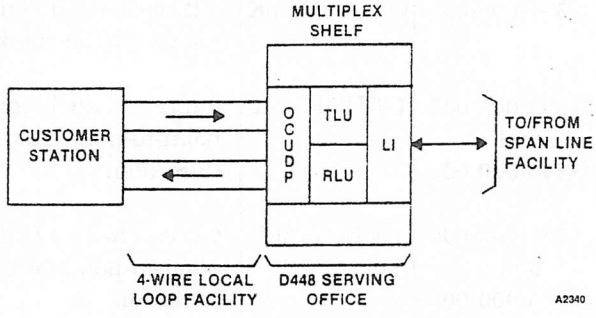

Fig. 1—OCUDP Application

A. Customer Station to OCUDP

2.02 The office channel unit dataport (OCUDP) is the office termination for the 4-wire local loop facility. This loop facility provides a transmission medium between customer station data equipment (described in Part 3 of this Section) and the OCUDP in a D448 shelf. The OCUDP receives customer data via the loop in a baseband bipolar format. Customer data consists of 6-bit word groups (for subrates; 7-bit word groups for 56.0-kb/s service) transmitted at a specific customer data rate. The OCUDP takes each of these 6-bit words and forms an 8-bit byte via byte stuffing. Each byte of customer data is then repeated an appropriate number of times until a 64.0-kb/s

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TABLE A

PART NO.	MNEMONIC	DESCRIPTION	MOUNTING LOCATION
628095-000-001	OIU/DDS	Office Interface Unit for DDS; one per channel bank required for interface to DDS network clock or to synchronize to D448 clock in stand-alone systems.	OIU position
628340-000-001	DS0DP	DS-0 Rate Dataport; allows 64.0 kb/s digital data access and error correction for 2.4, 4.8, and 9.6 kb/s data rates to/from T1, T1C, and T2-type lines.	Any channel unit position
628342-000-001 and 628342-000-003	DS0DP/56K	DS-0 Rate Dataport; allows 64.0 kb/s digital data access for 56.0 kb/s data rates to/from T1, T1C, and T2-type lines; w/o error correction.	Any channel unit position
628342-000-004 and 628342-000-006	DS0DP/56K	DS-0 Rate Dataport; allows 64.0 kb/s digital data access and error correction for 56.0 kb/s data rates to/from T1, T1C, and T2-type lines.	Any channel unit position
628350-000-001	OCUDP/2.4K	Office Channel Unit for 2.4 kb/s service; provides point-to-point 2.4 kb/s data transmission.	Any channel unit position
628352-000-001	OCUDP/4.8K	Office Channel Unit for 4.8 kb/s service; provides point-to-point 4.8 kb/s data transmission.	Any channel unit position
628354-000-001	OCUDP/9.6K	Office Channel Unit for 9.6 kb/s service; provides point-to-point 9.6 kb/s data transmission.	Any channel unit position
628356-000-001 and 628356-000-003	OCUDP/56K	Office Channel Unit for 56.0 kb/s service; provides point-to-point 56.0 kb/s data transmission w/o error correction.	Any channel unit position
628356-000-004 and 628356-000-006	OCUDP/56E	Office Channel Unit for 56.0 kb/s service; provides point-to-point 56.0 kb/s data transmission w/error correction.	Any channel unit position
628458-000-001	DTI	Data Test Interface; allows synchronization of customer test set with DS-0 level data for testing purposes.	DTI unit position

bit stream is created. For example, if the customer data rate is 2.4 kb/s, then the OCUDP adds a total of 800 additional bits per second and repeats these new 8-bit bytes 20 times to reach 64.0 kb/s. That is,

(2400 bits/second + 800 bits/second) x 20 = 64.0 kb/s.

Note: For 56.0-kb/s service, customer data is made up of 7-bit word groups. Hence, only one bit is added to this bit stream per word. The resulting 64.0-kb/s signal contains only one block of customer data.

2.03 The resulting 64.0-kb/s signal is made up of repeated bytes of customer data. There are two reasons for this:

(a) To provide the DDS-standard 64.0-kb/s bit stream; and

(b) To provide a method of error correction on signals to/from the customer station.

2.04 The OCUDP performs error correction by examining each of the repeated data bytes and performing a "majority vote." That is, each bit of each repeated byte is examined, a majority vote is taken, and the bytes are corrected so that all are identical. The corrected 64.0-kb/s customer data is then strobed out every 125 microseconds by the D448 transmit logic unit (TLU).

Note: In DDS hierarchy, the resultant 64.0-kb/s bit stream composed of multiple data bytes from a single customer is designated "DS-0A." A 64.0-kb/s bit stream composed of data from several customers is designated "DS-0B."

B. OCUDP to TLU

2.05 The TLU strobes data out of the OCUDP every 125 microseconds (8000 samples per second). It takes this DS-0A level signal and multiplexes it into a PCM bit stream along with the outputs of other channel units. The resultant signal is sent to the appropriate D448 line interface (LI) for transmission over the associated span line(s).

C. Span Line to OCUDP

2.06 The PCM bit stream from the span line facility enters D448 at the appropriate LI, where it is synchronized with a 64.0-kb/s clock from the office interface unit/DDS (OIU/DDS). The LI sends the received signal to the receive logic unit (RLU), which strobes this data into the OCUDP error correction circuitry every 125 microseconds. The OCUDP then performs error correction (Para. 2.04), discards the extra bytes used to make up the DS-0A level signal, and transmits the resultant baseband bipolar line signal at the original customer data rate to the customer via the 4-wire local loop.

D. DS0DP (Fig. 2)

2.07 The DS-0 rate dataport (DS0DP) produces a 64.0-kb/s (DS-0A or DS-0B) signal at its output. Refer to Fig. 3 for a diagram of the DS-0 type signal. It is used for intra-office trunking applications or as an entry point into the DDS network. In intra-office trunking applications, the output of a DS0DP in one D448 is run into the input of a DS0DP in another (co-located) D448. Here, the 64.0-kb/s output eliminates the need to return to the original customer data rate to transfer data from one D448 to another. Also, since the 64.0-kb/s DS-0A level signal is the entry level into DDS subrate multiplexers, the DS0DP provides a convenient access point for the DDS network.

CAUTION: If multiplexed PCM (customer) data at the 64.0 kb/s rate is being used, ensure that the error correction feature is switched off via switch S1 on the 629340 unit, or both switches S1 and S2 on the 628342 unit.

E. Test Equipment-Data Test Interface (DTI)

2.08 The DTI allows synchronization of customer data test sets with DS-0A level data for testing purposes. Only one per D448 office is recommended since the unit is not required for normal system operation. Hence, one DTI may serve a number of D448 multiplex terminals providing data service in a Telco central office.

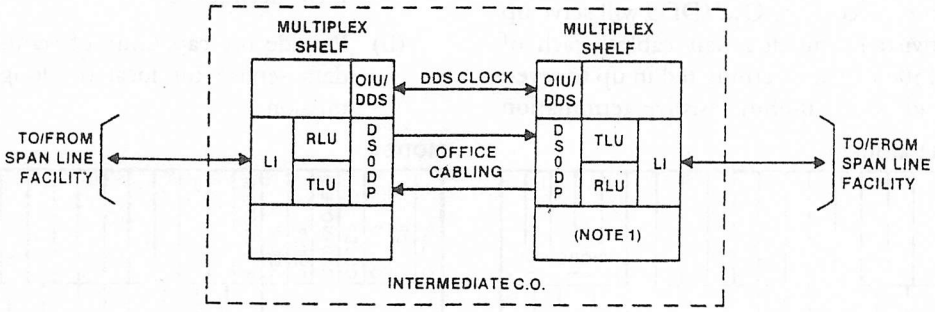


Fig. 2—DS0DP Application

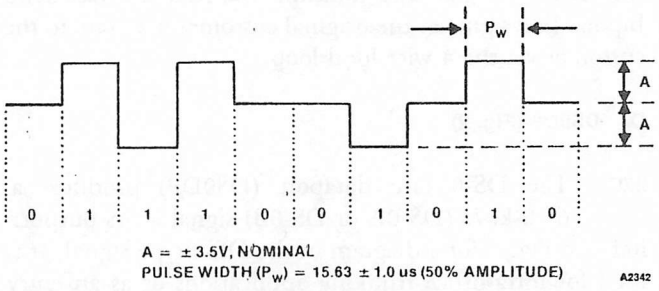


Fig. 3—Sample DS0DP Output (DS-0 Type Signal)

SYSTEM SYNCHRONIZATION

2.09 Whenever dataports are being used in D448, the OIU/DDS will be required to supply the appropriate timing signals so that data may be tightly synchronized to avoid slips. There are currently three ways that the OIU/DDS may be used:

(a) It may be phase-locked to an external DDS clock to permit synchronization of data with the DDS network or another D448 terminal;

(b) It may be used as a master clock source in a near-end D448 to synchronize both near-end and far-end D448 multiplex terminals for stand-alone private line data service; or

(c) It may be used in a loop timing mode in which it operates as a clock source in a far-end D448 slaved to a master clock source in a near-end D448.

2.10 The OIU/DDS is also equipped with a DDS clock out (DDSCLKO) tip/ring pair which may be used to "bus" a DDS network clock to other D448 multiplex terminals in the same office. One OIU/DDS will serve up to four 24AWG twisted, shielded pair cables, each of which is from 0 to 1500 feet and terminated in up to seven OIU/DDS units and one 150-ohm resistive termination per cable. The OIU/DDS units shall be connected in parallel (input-to-input) and the resistive termination shall be placed across the input of the last OIU/DDS connected to each cable.

SHELF LOADING CONFIGURATION

2.11 The OCUDP and DS0DP mount in any channel unit position in a D448 multiplex shelf. Dataports may be operated full-fill in the D448; up to 24 OCUDPs/DS0DPs may be mounted per digroup. One OCUDP is required per customer data channel. One DS0DP is required per data channel for D448 back-to-back office applications (intra-office trunking) or for each data channel requiring access to the DDS network. The OIU/DDS mounts in the OIU common unit position of a D448 multiplex shelf. Only one OIU/DDS is required per terminal for data applications.

Note: For the 56.0-kb/s OCUDP and DS0DP with error correction, two channel time slots are used (N, N+1). These units are physically located in channel unit position N. The adjacent unit slot may not be used.

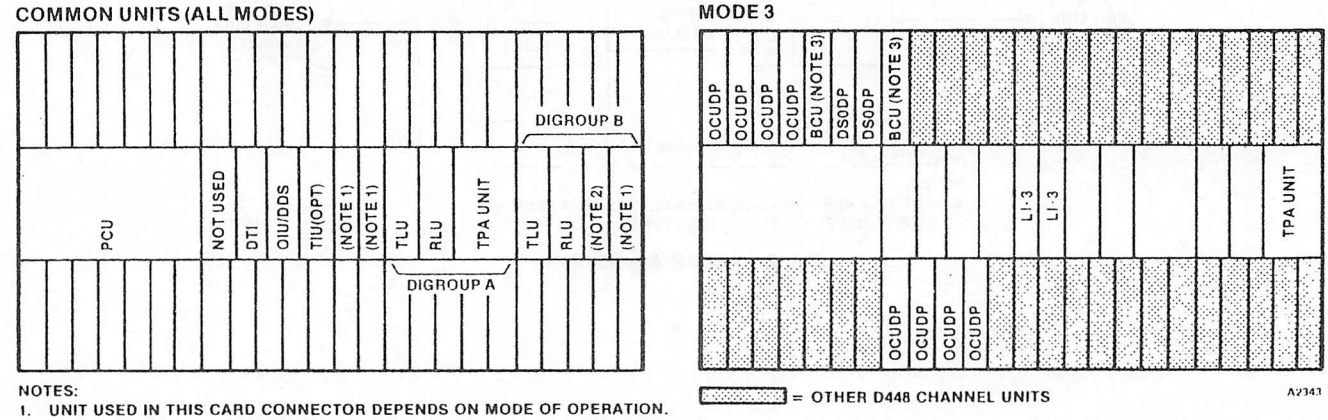
2.12 An example loading diagram for a dataport-equipped 23-inch D448 multiplex shelf is shown in Fig. 4. The example for the corresponding 19-inch mechanics is shown in Fig. 5.

TYPICAL APPLICATIONS (FIG. 6 AND 7)

2.13 ITT dataports may be used to:

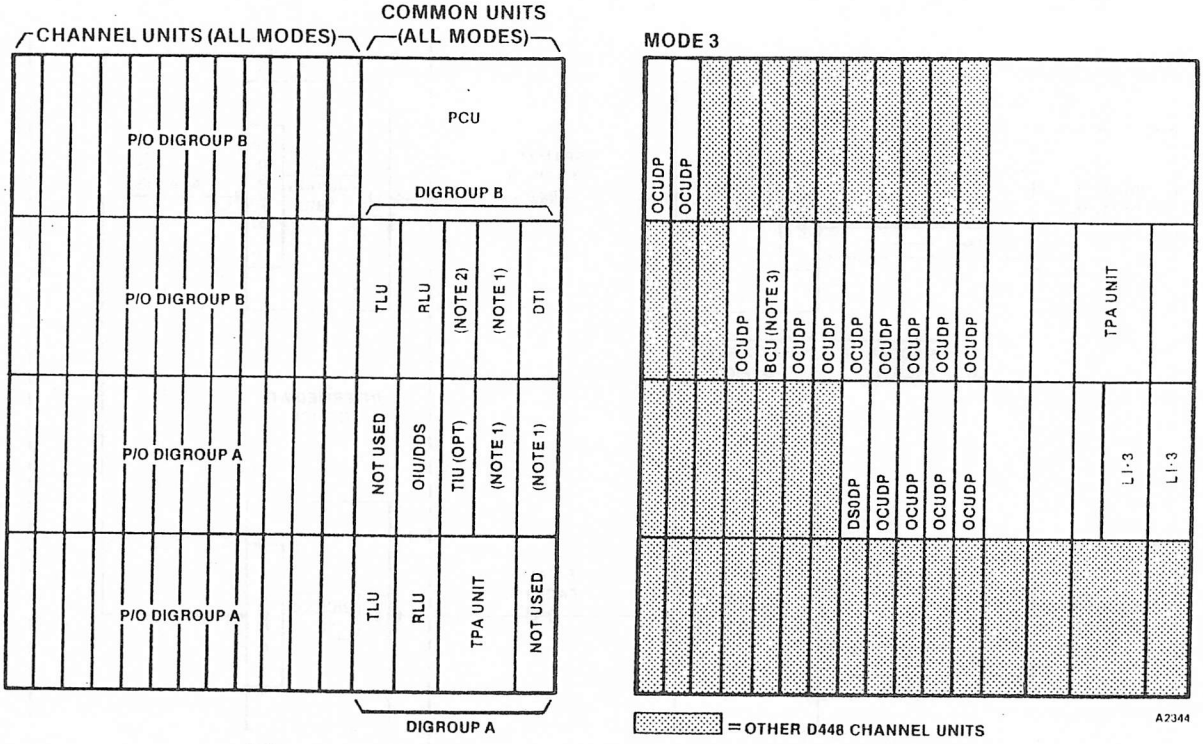
(a) Interface customer data channels with the AT&T DDS network; or

(b) Provide the capability of stand-alone private line data service for local (or long-haul) data transmission.



NOTES:
1. UNIT USED IN THIS CARD CONNECTOR DEPENDS ON MODE OF OPERATION.
2. CTU USED IN THIS CARD CONNECTOR IN MODE 1; FRONT PANEL COVERS CARD CONNECTOR UNIT BY TPA UNIT IN ALL OTHER MODES OF OPERATION.
3. BCU USED WITH 56.0 kb/s OCUDP OR DS0DP WITH ERROR CORRECTION FEATURE.

Fig. 4—D448 Dataport, 23-Inch Mechanics, Sample Shelf Loading (Mode 3 Shown)



NOTES:
1. UNIT USED IN THIS CARD CONNECTOR DEPENDS ON MODE OF OPERATION.
2. CTU USED IN THIS CARD CONNECTOR IN MODE 1; FRONT PANEL COVERS CARD CONNECTOR UNIT BY TPA UNIT IN ALL OTHER MODES OF OPERATION.
3. BCU USED WITH 56.0 kb/s OCUDP OR DS0DP WITH ERROR CORRECTION FEATURE.

Fig. 5—D448 Dataport, 19-Inch Mechanics, Sample Shelf Loading (Mode 3 Shown)

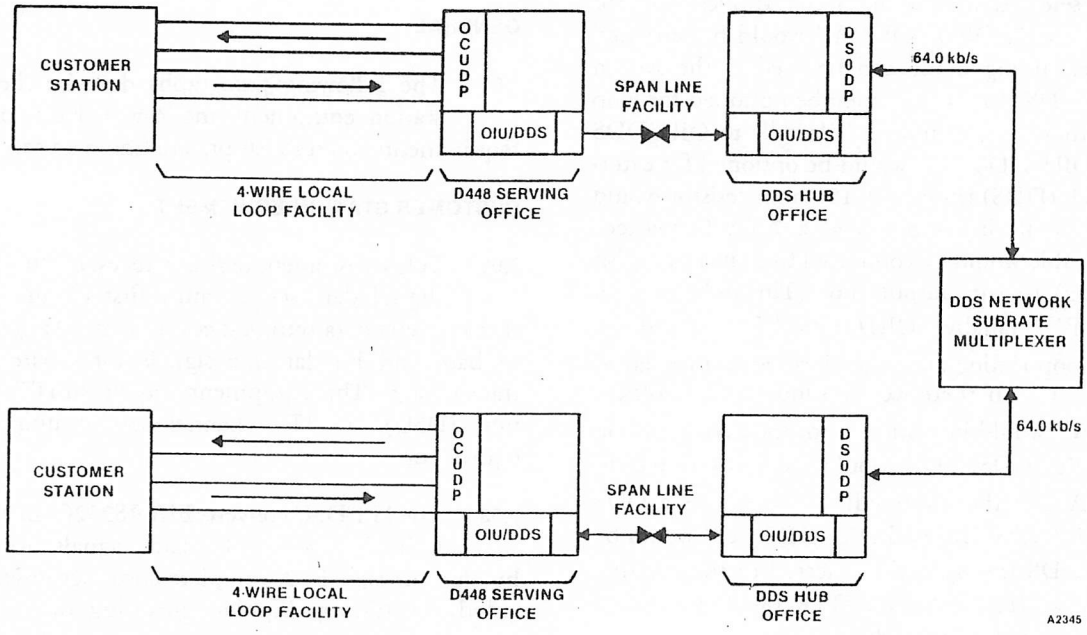


Fig. 6—Private Line Data Service, DDS Interface Application

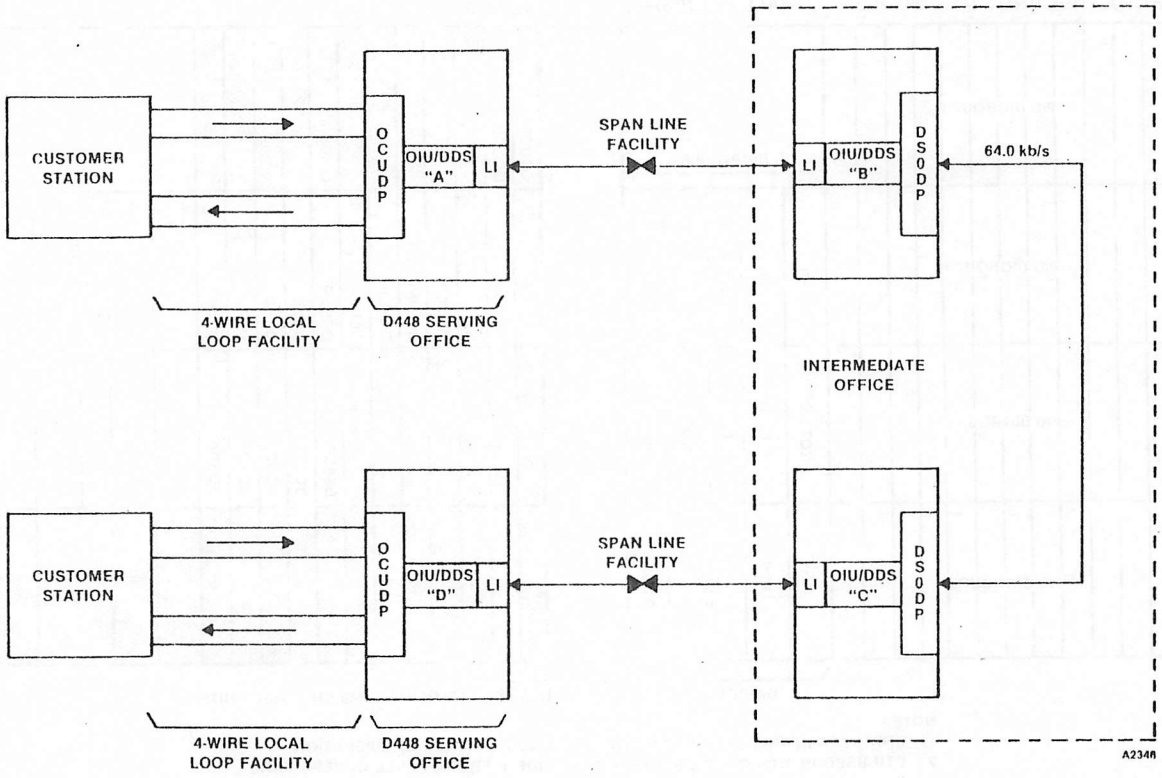


Fig. 7—Stand-Alone Private Line Data Service (Non-DDS) Application

Note: It is important to ensure that OIU/DDS options are properly selected for the intended application. For example, see Fig. 7. OIU/DDS "A" would be optioned for the master timing mode and be used as the system master. OIU/DDS "B" would then be optioned for loop timing and, therefore, would be "slaved" to OIU/DDS "A". Now, OIU/DDS "C" would be optioned for external office clock (DDS) timing. A 150-ohm resistor would be placed across its input pins and a 24AWG twisted, shielded pair cable would be connected from its input pins (Tip and Ring) to the output pins (Tip and Ring) of OIU/DDS "B". Finally, OIU/DDS "D" would be optioned for loop timing and, therefore, would be slaved to OIU/DDS "C". If there were no intermediate office, OIU/DDS "A" would be optioned for the master timing mode and OIU/DDS "D" would be loop timed to OIU/DDS "A". If the intermediate office were a DDS hub, both OIU/DDS "B" and OIU/DDS "C" would be optioned for DDS timing and connected to the external DDS office clock. Refer to Section ITTR-18-442 for option selection and installation procedures.

2.14 For additional information on the operation of individual dataport channel units, refer to the appropriate general description (Sections ITTR-18-3XX).

3. DATAPORT-CUSTOMER STATION INTERFACE

GENERAL

3.01 The following paragraphs describe the customer station equipment and 4-wire local loop facility requirements to establish private line data service.

CUSTOMER STATION EQUIPMENT

3.02 Telco customers desiring to establish private line digital data service must first obtain equipment that converts data terminal equipment (DTE) data signals to baseband bipolar line signals for 4-wire local loop transmission. This equipment may be an ITT data service unit (DSU), an ITT channel service unit (CSU), or equivalent.

3.03 The ITT DSU converts EIA RS232C, EIA RS449, or CCITT V.35 DTE data signals to baseband bipolar line signals. A complete customer interface is provided, including bipolar encoding/decoding, clock recovery, regeneration, and automatic line build-out (ALBO) circuitry. The ITT CSU is basically a line driver and receiver that provides only a transmit and receive pair, plus ground and status leads. The CSU is used by Telco customers having external clock recovery, regeneration,

recognition of control codes, and zero suppression capability within their DTE.

3.04 The DSU/CSU may be ordered in large quantities by Telcos that desire to provide these units to their customers for a monthly fee. The Telco customer may also choose to provide his own unit; however, only a DSU/CSU will provide access to private line digital data service.

4-WIRE LOCAL LOOP FACILITY

A. General

3.05 The following paragraphs describe the requirements for existing 4-wire local loop facilities used for baseband bipolar data transmission. This information is provided to allow Telco engineers to properly design local loops for DDS or other private line data service.

3.06 The DSU/CSU is the customer station termination for the 4-wire, nonloaded, local loop facility. The OCUDP is the office termination. Each presents a 135-ohm impedance to the cable; hence, all loss calculations and measurements use 135-ohm terminations.

Note: The design considerations for local loops include serving office cabling, trunk cable, terminating cable, feeder/distribution cable, and customer drop cable.

B. Local 4-Wire Loop Facility Requirements

3.07 Local loops intended for use with ITT OCUDPs should contain no load coils or build-out capacitors. The presence of these items on the local loop can seriously impair data transmission due to the irregularities in nominal cable characteristics they produce. For the same reason, the length of any bridged taps should be limited as specified in Table B. If the bridged taps are within acceptable limits, they need not be removed since their absence will result in a negligible improvement in data transmission.

TABLE B

BIT RATE	TOTAL BRIDGED TAPS	LONGEST SINGLE TAP
2.4, 4.8, or 9.6 kb/s	6000 ft/1828.8 m	6000 ft/1828.8 m
56.0 kb/s	2500 ft/ 762.0 m	2000 ft/ 609.6 m

3.08 When determining the eligibility of existing cable pairs for baseband bipolar data transmission, a knowledge of other services in the same cable and their unit or layer assignment is required. The following considerations must be made prior to assigning cable pairs for use with private line data service:

(a) Cables carrying unbalanced current pulses such as dc telegraph, revertive pulsing trunks, or dc alarm circuits should not be used for the loop facility;

(b) If 56.0-kb/s data service is being used, then the presence of any 15-kHz program channels, N-carrier, or single subscriber carrier systems designed in accordance with REA Spec. PE-62 must be determined. Pairs dedicated to 56.0-kb/s service must have non-adjacent unit/layer separation from any of these analog services due to interference created by 56.0-kb/s service pairs (via near-end crosstalk); and

(c) For 4.8- or 9.6-kb/s service, it is recommended that non-adjacent unit/layer separation from any program channels be maintained due to near-end crosstalk into these channels from 4.8- or 9.6-kb/s service.

Note: Baseband bipolar line signals are fully compatible with all T1 carrier, limited distance data channels, and W-type wire facilities. Cable pairs assigned to private line data service may be assigned to the same binder group as any of these digital services.

3.09 Once the cable pairs for data service have been tentatively chosen per the recommendations of Para. 3.07 and 3.08, it is necessary to determine if these cable pairs can support digital data transmission. Telco serving office records should provide the following information concerning the available pairs:

(a) Customer station-to-OCUDP distance;

(b) The length and gauge of each cable making up the local loop;

(c) The mutual capacitance of the cable; and

(d) The type of cable plant (i.e., aerial or buried).

Note 1: Interoffice sections are considered to be part of the local loop for cable routing which includes wiring through a non-DDS office.

Note 2: Most cables are specified with mutual capacitance of approximately 0.083 uF per mile. Extreme variations beyond 0.069 uF to 0.083 uF, such as that found on low capacitance cable, should be avoided.

3.10 The first step in qualifying existing cable pairs is to perform an expected measured loss (EML) calculation. The length of the local loop is limited by loss at a frequency equal to half the data service bit rate (e.g., 2.4 kHz for 4.8-kb/s service). For an EML calculation, the maximum loss is 31 dB (for all data rates). The EML calculation is performed as shown in Fig. 8. Descriptions of the symbols used in Fig. 8 are given in Table C.

EXAMPLE: Assume a given path chosen for 4.8-kb/s service is composed of 11 kilofeet of 22AWG buried, 8 kilofeet of 19AWG aerial, and 24 kilofeet of 24AWG buried cable. The mutual capacitance of all the cable is 0.083 uF/mile. Using Table D, the total EML would be:

11 kf, 22AWG, BURIED

Insertion Loss (IL) = 0.570 dB/kf
EML = IL x Length
= 0.570 dB/kf x 11 kf
EML_1 = 6.27 dB

8 kf, 19AWG, AERIAL

IL = 0.391 dB/kf
EML = IL x Length
= 0.391 dB/kf x 8 kf
EML_2 = 3.13 dB

24 kf, 24AWG, BURIED

IL = 0.757 dB/kf
EML = IL x Length
= 0.757 dB/kf x 24 kf
EML_3 = 18.17 dB

Total EML = $EML_1 + EML_2 + EML_3$
= 6.27 dB + 3.13 dB + 18.17 dB
= 27.57 dB

Since the pairs have less than 31 dB EML, acceptance testing can proceed. Record the values of total EML for each chosen path for comparison with actual measured loss (AML) values.

3.11 Once the EML has been determined and pairs have been tentatively selected, the results of the engineering estimates must be verified and faulty cable pairs must be identified. This is accomplished via acceptance testing, which consists of the following tests:

(a) A foreign voltage test;

(b) An insulation resistance test;

(c) A loop resistance test;

(d) An insertion loss or AML test;

(e) A background noise test; and

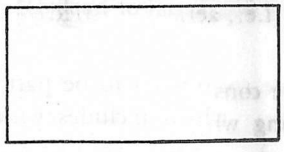
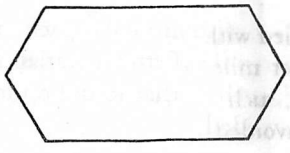
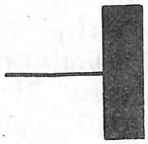
(f) An impulse noise test.

3.12 These tests should be made as soon as the cable pairs are assigned in order to correct any transmission difficulties prior to the service date. The results of the AML test are important since these test results indicate the accuracy of the EML calculation. The difference between the EML and AML should be within −2.5 dB to +5 dB. However, in no case should the AML exceed 34 dB.

Note: If the AML and EML do not agree as specified, recheck the EML calculations.

3.13 Procedures for performing acceptance tests on the local loop facility may be found in Section ITTR-18-470.

TABLE C

SYMBOL	NAME	DESCRIPTION
	Instruction Block	An instruction block is used to enclose a discrete statement. Each block has a reference number in brackets [ ]. This is for reference only and does not imply sequence.
	Decision Block	A decision block is used to enclose an interrogative statement. Each block has a reference number in brackets [ ]. This is for reference only and does not imply sequence. Each block normally has two responses (Yes-No); however, multiple responses are possible. For example, two "Yes" responses will be numbered Yes (1) and Yes (2). Always try the (1) response first. If the problem is not corrected, repeat the procedure with the (2) response.
	End-of-Procedure	The end-of-procedure symbol is used to denote that the flow-charted procedure, as defined by the procedure title, has been completed.

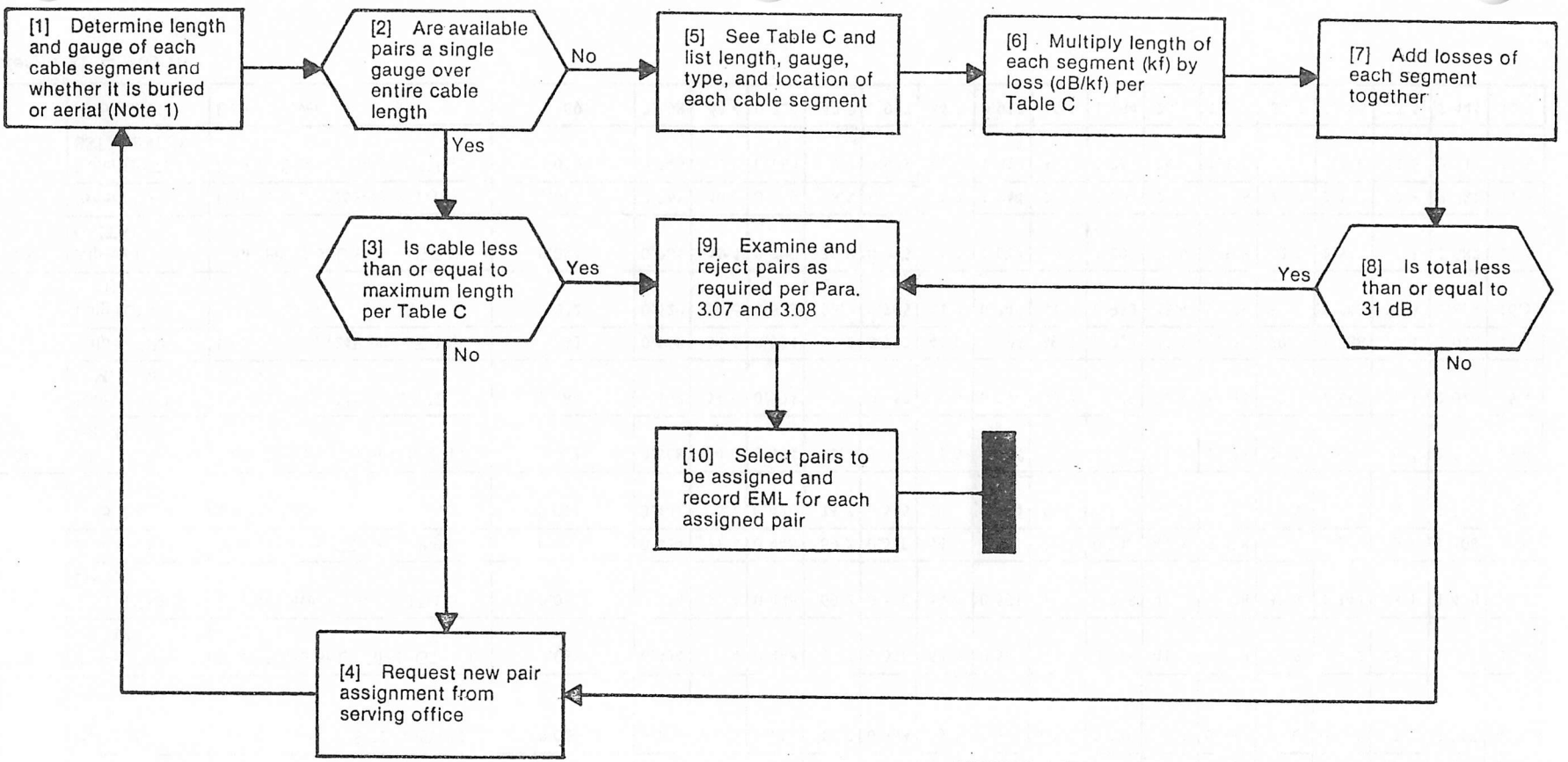

[1] Determine length and gauge of each cable segment and whether it is buried or aerial (Note 1)
[2] Are available pairs a single gauge over entire cable length
No
Yes
[3] Is cable less than or equal to maximum length per Table C
Yes
No
[4] Request new pair assignment from serving office
[5] See Table C and list length, gauge, type, and location of each cable segment
[6] Multiply length of each segment (kf) by loss (dB/kf) per Table C
[7] Add losses of each segment together
[8] Is total less than or equal to 31 dB
Yes
No
[9] Examine and reject pairs as required per Para. 3.07 and 3.08
[10] Select pairs to be assigned and record EML for each assigned pair
NOTES
1. Perform these procedures for each cable pair proposed for data service. See Example in Para. 3.10.
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Fig. 8—EML Calculation Procedures

TABLE D

CABLE GAUGE	INSULATION AND TYPICAL WE CABLE TYPES	CONSTRUCTION AND TYPICAL GENERAL CABLE CORP. AND GTE TYPES	NOMINAL CAPACITANCE, uF/mile	INSERTION LOSS (IL) IN dB/kf AND MAXIMUM LENGTH (ML) FOR 31 dB LOOP															
				2.4 kb/s				4.8 kb/s				9.6 kb/s				56.0 kb/s			
				BURIED 38°C (100°F)		AERIAL 60°C (140°F)		BURIED 38°C (100°F)		AERIAL 60°C (140°F)		BURIED 38°C (100°F)		AERIAL 60°C (140°F)		BURIED 38°C (100°F)		AERIAL 60°C (140°F)	
				IL (dB/kf)	ML (kf)	IL (dB/kf)	ML (kf)	IL (dB/kf)	ML (kf)	IL (dB/kf)	ML (kf)	IL (dB/kf)	ML (kf)	IL (dB/kf)	ML (kf)	IL (dB/kf)	ML (kf)	IL (dB/kf)	ML (kf)
19	Alpeth PIC (BHBA)	Unit, Filled or Unfilled (GT-19)	0.083	0.279	111.1	0.291	106.5	0.373	83.1	0.391	79.3	0.478	64.9	0.504	61.5	0.797	38.9	0.849	36.5
	Paper (CNB, CNBA, ENB, ENBCA, FNB)	Unit or Layer (19S-90, 19SU-90, GT-18)	0.084	0.279	111.1	0.291	106.5	0.373	83.1	0.391	79.3	0.478	64.9	0.504	61.5	0.797	38.9	0.849	36.5
	Pulp (ADB)		0.083	0.279	111.1	0.291	106.5	0.373	83.1	0.391	79.3	0.478	64.9	0.504	61.5	0.797	38.9	0.849	36.5
	Paper (TB, ANB, DNB, GNB)	Unit or Layer (19S-72, 19SU-72)	0.066	0.249	124.5	0.259	119.7	0.333	93.1	0.349	88.8	0.126	72.3	0.449	69.0	0.711	43.6	0.757	41.0
22	Alpeth PIC (BHAA)	Unit, Filled or Unfilled (GT-19)	0.083	0.434	71.4	0.448	69.2	0.570	54.4	0.591	52.5	0.748	41.4	0.778	39.8	1.342	23.1	1.408	22.0
	Paper (CSA, DSA, ESA)	Unit or Layer (22S-90, GT-18)	0.083	0.434	71.4	0.448	69.2	0.570	54.4	0.591	52.5	0.748	41.4	0.778	39.8	1.342	23.1	1.408	22.0
	Pulp (ADA)	Unit or Layer (GT-18, 22P-90)	0.083	0.434	71.4	0.448	69.2	0.570	54.4	0.591	52.5	0.748	41.4	0.778	39.8	1.342	23.1	1.408	22.0
	Pulp (NA, ANA)	Unit or Layer	0.073	0.407	76.2	0.420	73.8	0.535	57.9	0.554	56.0	0.701	44.2	0.730	42.5	1.259	24.6	1.320	23.5
24	Alpeth PIC (BKM)	Unit, Filled or Unfilled (GT-19)	0.083	0.568	54.6	0.594	52.2	0.757	41.0	0.794	39.0	0.998	31.1	1.051	29.5	1.888	16.4	2.012	15.4
	Paper (DSM, FSM, BSMA)	Unit or Layer (24S-90, 24SU-90, GT-18)	0.084	0.568	54.6	0.594	52.2	0.757	41.0	0.794	39.0	0.998	31.1	1.051	29.5	1.888	16.4	2.012	15.4
	Pulp (ADM)	Unit or Layer (24P-90, GT-18)	0.083	0.568	54.6	0.594	52.2	0.757	41.0	0.794	39.0	0.998	31.1	1.051	29.5	1.888	16.4	2.012	15.4
	Pulp (CSM, ESM)	Unit or Layer	0.072	0.529	58.6	0.553	56.0	0.705	44.0	0.740	41.9	0.930	33.4	0.979	31.7	1.758	17.6	1.874	16.5
26	Alpeth PIC (BKTA)	Unit, Filled or Unfilled (GT-19)	0.083	0.765	40.5	0.799	38.8	0.995	31.2	1.044	29.7	1.299	23.9	1.368	22.7	2.517	12.3	2.682	11.6
	Paper (DST)	Unit or Layer (26S-90, GT-18)	0.083	0.765	40.5	0.799	38.8	0.995	31.2	1.044	29.7	1.299	23.9	1.368	22.7	2.517	12.3	2.682	11.6
	Paper (BST, BSTA, BSTC)	Unit or Layer (26S-85, 26SU-85)	0.079	0.746	41.6	0.780	39.7	0.971	31.9	1.019	30.4	1.267	24.5	1.335	23.2	2.476	12.6	2.617	11.8
	Pulp (CST)	Unit or Layer	0.069	0.698	44.4	0.729	42.5	0.907	34.2	0.952	36.6	1.184	26.2	1.247	24.9	2.295	13.5	2.445	12.7

Note: 1 kf = 305 m.

4. OFFICE CABLING

4.01 Office cabling for D448 dataports varies, depending on the application. Generally, unshielded cable may be used for drop channel wiring from the D448 to the distribution frame. At an end office, shielded cable is not used with the OCUDP. In applications requiring the use of a DS0DP (Para. 2.07), 24AWG twisted, shielded pair cable should be used from the DS0DP to the DDS subrate multiplexer, or to the DS0DP in the adjacent D448, as appropriate.

4.02 The use of 24AWG twisted, shielded pair cable is also required for all external clock signals. This is particularly important where the DDS clock is concerned since the accuracy of this clock signal must be maintained to ensure proper transfer of data to/from the DDS network.

5. SPAN LINE FACILITIES

GENERAL

5.01 D448 may be used on T1, TX1C/T1C, T148C, or T2 digital PCM span lines. ITT dataports will operate on any of these lines, typically with no degradation of service.

SPAN LINE PROTECTION

5.02 ITT recommends the use of protection span lines, even though the use of protection spans for standalone private line data service is a Telco-determined factor. If protection spans are used, they should be provided on a 1-for-1 basis. It is recommended that Telcos give careful consideration to protection of service spans, particularly in applications where loss of customer data would critically affect the customers being served.

5.03 AT&T DDS network planning rules also recommend the use of protection lines under the following conditions:

(a) When the service span is longer than 15 miles/ 24.1 kilometers; or

(b) When the service span is carrying more than 20 data stations.

LINE QUALIFICATION

5.04 Due to the error correction feature of ITT dataports, T1/TX1C/T148C/T2 line qualification for data transmission is usually not required. Dataports will maintain an acceptable range of error-free operation even with marginal span lines. The individual Telco usually monitors span line performance, particularly on high-density routes, and it is assumed that marginally operating lines will be recognized and repaired as part of standard Telco practices.

5.05 Perform main trouble location procedures (Section ITTR-18-550), when data transmission trouble is reported. If these tests do not reveal the source of the trouble, qualification of the span line facility may be in order. Qualification procedures should only be performed when standard trouble location procedures do not indicate abnormal transmission operation.